# SIMTECH 2007 … and Beyond

**Lana McGlynn**
**ODUSA(OR)**
**M&S and Light Force Studies**
**The Pentagon, Washington, DC, USA**

**Dr. Stuart H. Starr**
**The MITRE Corporation**
**7515 Colshire Drive,**
**McLean, VA, 22102, USA**

## Abstract

During the course of over a decade, the Military Operations Research Society (MORS) has sponsored a sequence of workshops on the subject of simulation technology. The broad objectives of these workshops were to identify and prioritze the needs of the users of military modeling and simulation (M&S), assess the probable evolution of M&S technology, and to identify potential user shortfalls and opportunities to ameliorate them. This paper summarizes the major findings and recommendations of the last of these workshops, Simulation Technology (SIMTECH) 2007. It focuses on the M&S needs for three major user groups: analysts, acquirers of systems, and educators and trainers. For each of these user groups, a vision is articulated and recommendations are posed to realize those visions. The paper concludes with a brief look at promising new M&S initiatives in each of these functional areas as well as major residual issues that confront the M&S community.

### A. Context

Approximately a decade ago, the Military Operations Research Society (MORS) sponsored a series of three workshops under the rubric of Simulation Technology 1997 (SIMTECH 97). Those workshops focused on identifying and satisfying the simulation technology needs of the analyst in the late 1990s. Ultimately, that activity culminated with a set of findings and recommendations on four major themes: lifecycle management for Modeling and Simulation (M&S); a workstation for the analyst; dealing with "soft factors" (e.g., cognitive factors, performance modulators) in M&S; and responding to M&S's needs for data. In 1997, several of the original organizers of SIMTECH 97 believed that it was an appropriate time to re-assess the results of the prior workshops and to look ten years into the future.

The overarching goal of this new series of workshops was to promote more effective dialogue between the M&S technology community and an expanded set of users of M&S: analysts, acquirers and educators and trainers.

Consistent with this goal, four subordinate objectives were identified:

- Review and assess the findings and recommendations from SIMTECH 97;
- Identify and prioritize the needs of the users of military M&S;
- Assess the probable evolution of M&S technology over the next decade; and,
- Identify potential user shortfalls and opportunities to ameliorate them.

# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **2006** | | **00-00-2006 to 00-00-2006** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **SIMTECH 2007...and Beyond** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **MITRE Corporation,7515 Colshire Drive,McLean,VA,22102-7539** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES
**The original document contains color images.**

14. ABSTRACT

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | | **9** | |

To satisfy these goals and objectives, two workshops were convened. The first workshop was conducted at GRCI, Tysons Corner, VA, on 16-18 December 1997. It began with retrospective assessments by working groups organized around the four major themes that were addressed in SIMTECH 97. Drawing on the lessons learned from the retrospective assessments, the participants were reorganized into parallel clusters of M&S users and technologists. The users identified and prioritized the M&S needs of analysts, acquirers and educators and trainers. The technologists formulated a taxonomy for M&S technology and, within that context, forecast conservative and aggressive estimates for the state of M&S technology by 2007.

The second workshop was conducted at the Institute for Defense Analyses (IDA), Alexandria, VA, on 18-20 August 1998. The workshop began by having hybrid working groups of M&S users and technologists refine their products from Workshop I. Subsequently, after a sequence of M&S technology presentations, these hybrid working groups identified a comprehensive set of shortfalls (subsuming policy, management and technology) and formulated recommendations to ameliorate them.

This paper summarizes the major findings and recommendations of SIMTECH 2007. In addition, it looks beyond those results to identify promising new initiatives and major residual issues that have emerged since the completion of SIMTECH 2007.

## B. Key Products

This section of the paper introduces a technology taxonomy that was developed during SIMTECH 2007 and summarizes the results of the three functional assessments.

**B.1 Technology Taxonomy and Assessment.** As a basis for simulation technology projections, a taxonomy was developed that can be depicted as a jig saw puzzle with four interlinking pieces (see Figure 1):

- modeling methodology (i.e., the theories, processes, algorithms and information that support the conceptualization of a model);
- development methodology (i.e., the tools, techniques and software used in architecting, designing and implementing a model);
- computation and communications technology (i.e., the platform the M&S application is hosted on, how it connects to other M&S applications, and how M&S application developers and users connect to one another); and
- data and information technology (i.e., the processes and tools needed to acquire and transform data and information).

For each of these areas, technology projections were made under conservative assumptions (e.g., continuation of current investment priorities) and aggressive assumptions (e.g., substantial increase in priority with the subsequent likelihood of a breakthrough). The results of those technology projections are presented later in the paper.

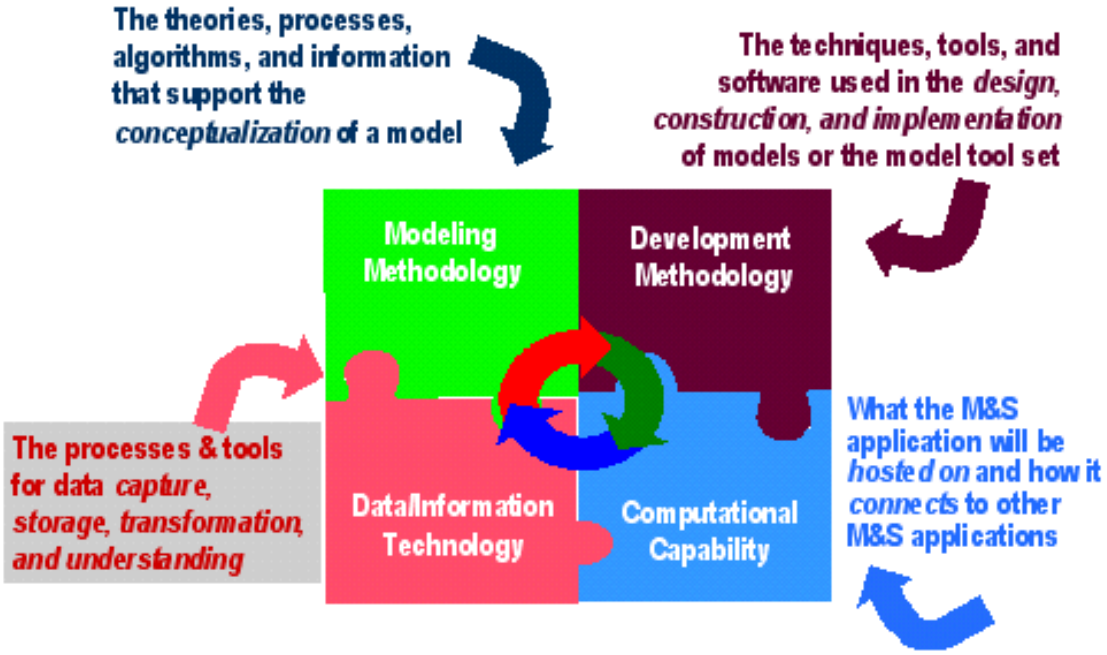


**Figure 1: SIMTECH 2007 Technology Taxonomy**

As a baseline, the Technology Working Group characterized the state of simulation technology as of 1998. They concluded the following. First, in the area of modeling methodology many major simulations are too hard to use and their results are too hard to understand. Second, it was observed that the acquisition of simulations is often equivalent to the acquisition of large, complex software systems. Currently, the scale of most contemporary military simulation systems is such that the community can not reliably acquire them within cost and schedule goals. Third, it was concluded that computational capability was not a major limiting factor for the bulk of simulation needs. Finally, it was observed that data presents a very difficult, pervasive problem, both in its acquisition and its transformation into products needed by the M&S community.

**B. 2 Functional Area Assessments.** For the functional areas of analysis, acquisition and education and training, top-down assessments were performed. These include an articulation of a vision for the functional area; an identification of associated needs (in policy, management and technology); a characterization of perceived shortfalls (e.g., an identification of cases where technology needs exceeded aggressive projections (assessed as "red") and cases where technology needs fell between conservative and aggressive projections (assessed as "amber")); a set of recommendations to ameliorate perceived shortfalls; and sensitivity assessments to establish the robustness of the recommendations.

**B.2.1 Analysis**. The Analysis Working Group defined a vision describing the following operating circumstances of the analyst in 2007. First, multidimensional demands of joint, coalition and international operations will best be met by conducting analysis via teams that mix the right skills and experience to answer pertinent issues. Such teams will match analysts with a broad range of other professionals, including specially trained simulators and communicators. Second, in ten years, the analyst will find it easy and normal to work in a distributed analysis environment in direct support of the commanders and decision makers at all levels, wherever they

are. Finally, there will be a strong command and control component to analytic issues, which the simulations of the day will be better prepared to address. The growth of a new generation of analytic tools, decision aids, and data bases will allow the analyst to focus first on the question of interest and then settle on the appropriate tools for the job.

The Analysis Working Group also proposed recommendations in the areas of an analyst tool chest, procedures, data, and people. A concise summary of those recommendations follows.

• Tool Chest. The Analysis Working Group recommended that a community-wide effort be initiated to create an Analyst Tool Chest. There are three major components of this proposed effort. First, work should be undertaken to create and sustain M&S that treat command and control explicitly to deal with key operations of interest. Consistent with emerging issues of interest, two classes of operations were emphasized. First there is a need for tools to analyze the missions associated with operations other than war (OOTW). This includes humanitarian assistance, disaster relief, and peace operations. Second, new concepts of warfare are emerging for which M&S are needed. This includes network centric warfare, information warfare, small unit operations (particularly in complex terrain), non-lethal weapons, and counter-terrorism. Next, the Working Group recommended that existing tools should be augmented with the latest conceptual thinking and techniques. These include advances in complexity and chaos theory and new tools such as agent based models to study emergent behavior and genetic algorithms to derive optimal solutions to complex, non-linear problems. Finally, the Working Group recommended that new features be incorporated into our tools to make them more flexible and easier to use. Among the features identified were intelligent agents to "bookmark" key events in a simulation to facilitate "what if…" analyses, enhanced visualization capabilities to facilitate communications with decision makers, and data mining and knowledge discovery tools to deal with the immense loads of data generated in simulations and experiments.

• Procedures. In the area of procedures it was recommended that analysts be encouraged to explore "study space" fully. This reflected the concern that many studies artificially limited their scope to conditions that did not reflect the full range of risks and uncertainties that were of interest to the decision maker. Second, it was recommended that advanced warfighting experiments should be supported by an analytic process to derive valid conclusions and usable data. This process includes both a solid structure to define the experiments and analytic procedures to extract valid insights from the volumes of data generated. Finally, in order to continue the advancement in analysis, it was important to establish a program of continued research that addresses both military phenomenology and scientific advancement. In particular, it was recommended that further effort be invested in pursuing and developing the "new sciences"(e.g., complexity, chaos theory) and teaching their theory and application to new practitioners.

• Data. In the area of data, it was recommended that a comprehensive process for data management be instituted. In addition, it was proposed that technologies be developed for data extraction and analysis of useful data from events (e.g., by employing intelligent agents) and information from data (e.g., by employing innovative visualization tools). In addition, to provide assistance to analysts in identifying and gaining access to verified, validated, and certified data, it is recommended that a "Help Desk" be established.

• People. In the area of people, it was recommended that a formal educational course be established that trains analysts in the techniques and processes involved in complex analysis. Moreover, since capabilities will continue to emerge and be refined, a continuing education process is recommended to keep analysts qualified in the latest techniques. In addition, it was

recommended to develop educational approaches that highlight the ability to design a complex, high dimensionality analysis, to execute it in a distributed fashion, and to conduct a thorough analysis of the outputs. While the tools of experimental design, stochastic modeling, and computer science will fill much of the need, education and practice in a focused curriculum will result in a more responsive, innovative analysis.

**B.2.2 Acquisition.** The vision of the Acquisition Working Group is a new acquisition paradigm that yields substantial reductions in time, resources, risk, and total ownership costs throughout the life cycle process, while simultaneously increasing the system's quality, military worth, and supportability.

In order to achieve those benefits, it is perceived that the intelligent use of simulations is the critical enabler. These simulations must be robust, used collaboratively by all of the stakeholders involved in the acquisition, and integrated across the phases and functions of the system life cycle. In addition, to take full advantage of the investments in these simulations, steps should be taken to ensure that they are reused to support related system programs. This philosophy is often referred to as Simulation Based Acquisition (SBA).

The Acquisition Working Group observed that it will require concerted changes in policy, organizations and relationships, people, resources, and tools if their vision is to become a reality. Within those areas they made the following recommendations.

• Policy. Incentives must be established to motivate stakeholders in the acquisition process to share M&S and data. This might entail providing additional resources to those program managers that manifest this behavior. In addition, there is a need to redefine the roles and responsibilities between government and industry in the acquisition process. It is anticipated that it may require that more of the development responsibility is shifted to industry. Finally, in order to maximize the potential of SBA, changes should be made to enhance the utilization of international products and services.
• Organizations and Relationships. If SBA is to become a reality, it will be necessary to establish partnerships that permit the sharing of data and models. Trust must be a cornerstone of those relationships. Second, the current acquisition process is beset with communities that do not communicate or work effectively with one another. This includes, *inter alia*, users, developers, testers, trainers, and maintainers. It is hoped that if M&S and data can be shared flexibly across those community lines, it will serve to break down those "stovepipes". Finally, there is a need to establish dedicated, enduring pilot and flagship programs. Only by pursuing them will the acquisition community know and share enough about the paradigm to make it a routine way of doing business.
• People. People are at the heart of the SBA paradigm. Thus it is critical to educate and train them on the vision and subsequently hold them accountable for achieving the vision.
• Resources. There is an old cliché that if you want to save money, you must first invest money. In the case of SBA, there is a need to make up-front investments in the M&S infrastructure to provide the tools that the community requires.
• Tools. There are four key recommendations in the area of tools to support SBA. First, there must be far greater reliance on M&S in the acquisition process. This use must begin very early in a program and continue throughout its lifetime. Second, there is a need to share this M&S and associated data. This sharing must extend across functional lines (e.g., the developer should share with the trainer) as well as across program lines. Third, there is a need for assured environments within which these M&S can be employed. These environments must be interoperable to facilitate the rapid federation of M&S and secure to allow their use with sensitive and classified information. Finally, since these distributed environments will require the passage of voluminous

amounts of data, it would be highly desirable if adequate bandwidth could be made available on demand.

**B.2.3 Education & Training.** The Education & Training Working Group envisioned a future in which individuals will be educated on "how to learn." Subsequently, those individuals will receive training (i.e., "how to do") that is just-in-time, just enough, tailored to needs, and delivered when and where needed. Consistent with that vision, education and training will be integrated, capitalize on research and leverage non-DoD technology advances. In addition, analysis, acquisition and education and training will provide mutual support and exploit common resources.

The Education and Training Working Group formulated recommendations in six areas: training methods, needs assessment, "come to the people," individual responsibility, life-long process and cross-functional sharing.

• Training Methods. Develop new methods of training in applying the new technologies. DoD must adopt methods that will help change the **way** people learn in addition to **what** they learn. New learning methods that stress the ability to assimilate information will likely be required, instead of traditional methods that focused on memorization or repetition.

• Needs Assessment. Conduct a periodic "Needs Assessment." This assessment will: (1) identify shortfalls in the training and education domains; (2) prioritize these needs and fund efforts to correct them via an implementation plan; and, (3) develop a feedback process that will periodically revise this plan .

• "Come to the People." Make the education and training process significantly more efficient to deal with the consequences of the smaller forces (downsizing), the increased OPTEMPO/PERSTEMPO, and the increasingly complex world. This training/education process must come to the people, and not the people to it. It may be prudent to oversee the application advanced distributed learning (ADL) through the formation of a program office that can coordinate the implementation across all of DoD.

• Individual Responsibility. Individuals must take more of the responsibility for training and educating themselves. In support, DoD must adopt a policy that will provide incentives for individuals to improve themselves through education and training. Likewise, institutions must share in this process so that available resources are not squandered.

• Life-long Process. Implement a life-long education and training process because the world is rapidly changing, the rapid evolution of technology often makes knowledge obsolete within only a few years, and each person needs to be proficient in more skills (fewer people engaged in more complex work). In support of this process, personnel systems must accommodate the need for continuous training throughout the career cycle. To facilitate this process, broad-based training must be integrated with specific, tailored training throughout a soldier's career. Links to non-military institutions of higher learning (e.g., universities, community colleges) will be necessary to expand the knowledge base for such information.

• Establish a Multi-faceted Research Program. A research program is needed in four key areas. First there is a need to capture and extend theory on "how we learn" and "how to teach". Second, it is important to develop human performance metrics to support E&T evaluation. Third, there is a need to capture, store, and make accessible information on individual and organizational performance and E&T system performance. Finally, is vital to create a comprehensive program on Human Behavior Representation.

## C. Overarching Findings and Recommendations.

This section briefly summarizes the overarching findings and recommendations that the Workshop developed.

Each of the plenary speakers at the second workshop identified M&S as a key enabler to promote *revolutions* in analysis, acquisition and education and training. This hypothesis was validated by the working groups.

Several of the plenary speakers observed that many of the obstacles to these revolutions are *cultural* in nature. Among the more important cultural obstacles identified were institutional barriers (e.g., the need to go from "stovepiped" organizations to more collaborative organizations that would promote the more efficient sharing of tools, data and expertise); modeling and simulation barriers (e.g., transitioning from the inflexibility of current M&S to more flexible M&S to explore easily new operational concepts, doctrines, procedures, and the human dimension); and process barriers (e.g., transition from the use of a few, "blessed" scenarios to a full range of scenarios that span the mission space). Again, these observations were extended and validated by the working groups.

From a technology perspective, the working groups concluded that the most significant shortfalls were projected to occur in modeling methodology (i.e., adequate representation of key cognitive factors, performance modulators and computer generated forces); development methodology (i.e., system architecture/engineering; system composability, scalability; and standards for design, interoperability and reuse); and data/information understanding (i.e., tools for dealing with data acquisition, transformation, and access; tools to support collaboration). In almost all cases, these projected technology shortfalls cut across individual functional areas. It is notable that each functional working group also opined that commercial developments in communications and computing would probably *not* constrain M&S applications, with the exception of security needs (see Figure 2).

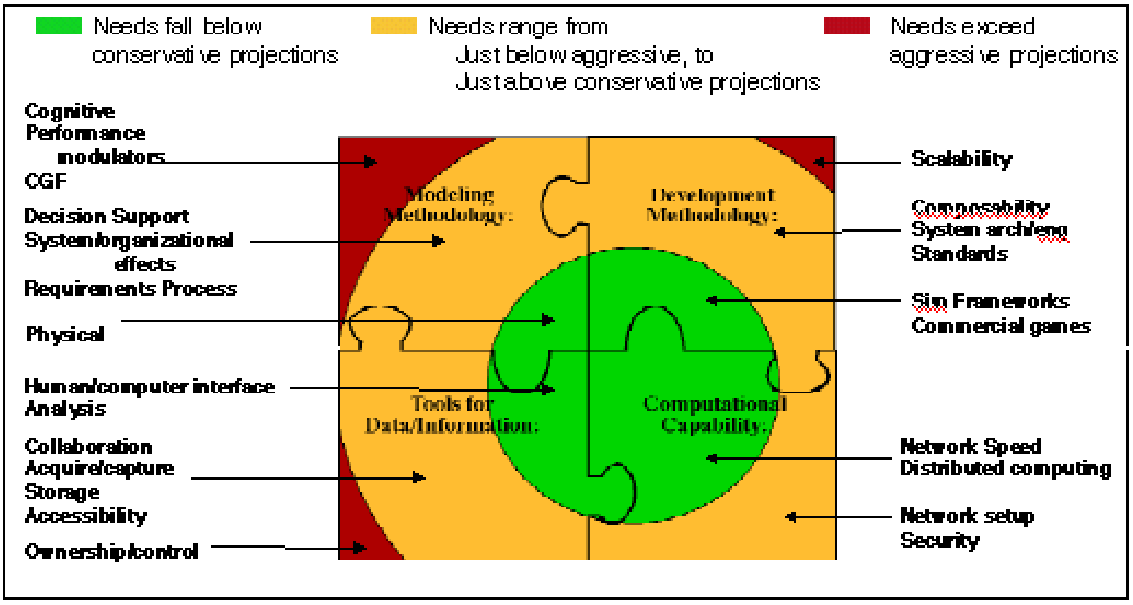


**Figure 2: Aggregate Comparison of User Needs and Technology Projections**

To facilitate the development of a better balanced M&S Science and Technology (S&T) investment strategy, it is necessary to develop a clear, comprehensive audit trail for current M&S S&T programs and plans.

To promote needed community sharing of tools, data and expertise, organizational focal points are required for SBA and ADL. These organizations should champion these processes, promote pilot programs, monitor commercial developments, begin to establish the community infrastructure needed to "boot strap" the processes and assure the full scope of cross-cutting activities are undertaken (e.g., ensure that education and training needs are treated adequately in SBA).

An expanded family of flexible, readily tailorable M&S is needed to address many user needs. Although on-going monolithic model developments (e.g., Joint Warfare System (JWARS), Joint Simulation System (JSIMS) ) will probably prove to be central elements of this family, they will almost certainly not be sufficient to satisfy the needs of all users. To complement them, "boutique" models are needed that address all aspects of the expanding mission space (e.g., asymmetric conflict; new operational concepts). These include system dynamics models (to provide the ability to quickly scan and pre-filter scenario space) through virtual M&S (to capture the effects of distributed teams of people under stress). In particular, the demands of advanced warfighting experiments mandate new classes of M&S, which are sufficiently flexible to explore easily new operational concepts, and companion education and training experimentation plans to address the subjects' needs for associated training.

To redress identified M&S technology shortfalls that affect all users of M&S, undertake organized research programs in "soft factors" (e.g., cognitive factors, performance modulators, computer generated forces), data (e.g., tools to capture, transform, and access data) and selected subjects in fundamental / applied research (e.g., agent-based modeling, search and model building; variable structure simulation; multi-resolution modeling; role of interactiveness in discovery and analysis). Mechanisms must also be established to ensure that the results of these research programs are injected into the practice of M&S.

## D. … And Beyond

During the last three years, since the conclusion of the SIMTECH 2007 workshops, there have been some notable advances in M&S. The following section briefly summarizes some promising new initiatives as well as major residual issues.

In the area of analysis, there have been several initiatives that have addressed key issues that were identified in SIMTECH 2007. First, SIMTECH 2007 stressed the importance of treating command and control as a first order factor in analyses of defense issues. Consistent with that emphasis, NATO's Studies, Analysis, and Simulation Panel (SAS-03) issued a Code of Best Practice (CoBP) for C2 Assessment (Reference 1). Efforts are underway in SAS-026 to extend the preliminary code beyond assessment of conventional war to include assessments of operations other than war. In addition, SIMTECH 2007 observed that promising developments in the "New Sciences" should be monitored carefully. One promising activity in that area is the USMC's Project Albert (Reference 2). It is in the process of developing new agent-based models, exploring options for orchestrating multiple assessment tools, developing new visualization tools, and developing techniques to perform data farming.

In the area of acquisition, a number of Service initiatives are underway which are attempting to implement the SBA paradigm. The Army is developing a facility at Ft Belvoir, VA, to support the

acquisition of key elements of its emerging Objective Force. This Objective Force Battlespace facility, which was formerly known as the Joint Virtual Battlespace (JVB), is using the High Level Architecture (HLA) to federate a number of community M&S assets. Similarly, the USAF at the Electronic Systems Command (ESC), Hanscom AFB, MA, is creating an acquisition environment, the Joint Synthetic Battlespace, to support the acquisition of new C2 systems.

In the area of Education & Training, one of the more interesting developments has been at the Institute for Creative Technologies which the US Army recently established at the University of Southern California, Marina del Rey, CA. The Institute is attempting to take advantage of the techniques developed by the cinema and electronic game industries to develop training tools that are compelling and effective. Early efforts have focused on integrating enhancements in natural language recognition, visualization, and artificial intelligence to generate a prototype system for training small teams in support of operations other than war.

In addition, the DoD is pursuing an Advanced Distributed Learning initiative that is consistent with the SIMTECH 2007 recommendation that training should “come to the people”. It is seeking to take advantage of new advances in information systems to enable users to have access to training any where at any time.

Although these recent advances are heartening, there are still major issues remaining that the community must confront. The following represent a few of these issues. In support of analysis, it is widely recognized that there is a need for new tools that enable the analyst to flexibly explore alternative combinations of doctrine, operational concepts, training, leadership and materiel. This is of particular importance in the area of joint experimentation where efforts are underway to assess proposed concepts to transform the US military. In addition, there is a need for tools to support the assessment of critical new missions such as homeland security and counter-terrorism operations. In support of acquisition, it is understood that new M&S tools and environments are necessary but not sufficient to realize the SBA paradigm. If this initiative is to be successful, it will require corresponding changes in culture and people and the philosophy behind the allocation of resources to support acquisition. Finally, the E&T community has residual challenges to confront as it seeks to achieve an initial operational capability with JSIMS. The program has made substantial progress since it embraced the HLA, but there are still substantial challenges associated with completing and federating the key component simulations.

## E. References

1. RTO-TR-9 AC/323(SAS)TP/4.*Code of Best Practice (COBP) on the Assessment of C2*. Neuilly-Sur-Seine Cedex, France, March 1999.
2. Project Albert, http://www.projectalbert.org
Note: for the final report of SIMTECH 2007 Mini-Symposium and Workshop, contact Military Operations Research Society, 101 South Whiting Street, Alexandria, VA, 22304, USA (www.mors.org)